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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/936,818	02/28/2002	Koji Takahashi	829-585	1578

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EXAMINER	
SONG, MATTHEW J	
ART UNIT	**PAPER NUMBER**
1722	

DATE MAILED: 01/23/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	09/936,818	TAKAHASHI ET AL.
	Examiner	Art Unit
	Matthew J. Song	1722

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *07 November 2005*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *29,32,33 and 38-62* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *29,32,33 and 38-62* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

2. Claims 29, 32-33, 38-39, 42-50 and 53-62 are rejected under 35 U.S.C. 103(a) as being unpatentable over Jiang et al (US 5,956,364) in view of Tomomura (WO 98/44539), where US 6,358,822 is used as an accurate translation.

In a method of making a semiconductor device, note entire reference, Jiang et al teaches molecular beam epitaxy is used to make required multiple layers of material layers, such as indium gallium arsenide aluminum nitride (col 3, ln 1-40), this reads on applicant's III-V compound semiconductor including, as a V group components, nitrogen and at last one of arsenic (As), phosphorous (P), and antimony (Sb).

Jiang et al does not teach supplying aluminum and ammonium to a surface so as to obtain a mixed crystal with a composition comprising nitrogen and wherein the substrate temperature is 450-640°C.

In a method of forming a mixed crystal of III-V compound semiconductor, note entire reference, Tomomura teaches a Group III-V compound semiconductor layer including nitrogen and at least another Group V element grown by molecular beam epitaxy and is grown by irradiating a substrate with material molecular beams in crystal growth chamber so evacuated that the mean free path of material molecules is larger than the distance between the substrate and molecular beam sources, a nitrogen compound is used as a nitrogen source and molecules of the nitrogen compound decompose after they reach the substrate surface and only nitrogen atoms are incorporation into the growing semiconductor crystal (abstract). Tomomura also teaches a nitrogen hydride, NH_3, is used as the nitrogen compound and the substrate temperature is maintained at 500-750°C during crystal growth ('822 col 3, ln 1-50). Tomomura also teaches the substrate is a compound semiconductor which as a zinc blend structure and the substrate surface has an off-angle of 5-15° from {100} plane to a {111}A plane and decomposition is promoted and high incorporation efficiency of nitrogen is achieved on this substrate surface ('822 col 3, ln 50 to col 4, ln 5). Tomomura also teaches Al, Ga and In molecular beams were directed to a substrate by heating a solid metallic material using a Knudsen cell ('822 col 5, ln 10-55). Tomomura also teaches incorporation efficiency of nitrogen into the crystal can be improved ('822 col 4, ln 5-35). Tomomura also teaches GSMBE, CBE and MOMBE ('822 col 15, ln 1-30 and col 1, ln 5-55). Tomomura also teaches a timing chart for supplying reactant gases in sequence and one cycle of the source supply sequence is set in a range of 0.5 to 5 molecular

layers to form a mixed crystal with uniform composition ('822 Fig 6 and col 10, ln 25-67). Tomomura also teaches the method can be used for mixed crystals of a II-v compound semiconductor, which includes nitrogen, at least one other the Group V elements As, P, Sb and Bi, and at least one of the Group III elements B, Al, Ga, In, and Tl (col 15, ln 1-31).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Jiang et al with Tomomura method of forming Group III-V compound semiconductor with ammonium at a temperature of 500-750°C using MBE to improve incorporation efficiency of nitrogen into a crystal (col 3, ln 25-35 and col 4, ln 1-20). Overlapping ranges are held to be obvious (MPEP 2144.05).

The combination of Jiang et al and Tomomura does not teach the crystallization of the nitrogen from the ammonium which is supplied to the surface of the crystal into the surface of the crystal is accelerated by the aluminum supplied to the surface of the crystal. However, this feature is inherent because the combination of Jiang et al and Tomomura teaches supplying NH_3 and aluminum to the surface of a crystal, as applicant; therefore the claimed effect of supplying the NH_3 and aluminum to the surface would be inherent because the combination of Jiang et al and Tomomura teaches a similar process.

Referring to claim 32, the combination of Jiang et al and Tomomura does not explicitly teach a nitrogen composition is controlled based on an amount or composition ratio of added aluminum. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Jiang et al and Tomomura by controlling a nitrogen composition based on a composition of aluminum to obtain an epitaxial layer with a desired stoichiometry. Changes in composition are held to be obvious (MPEP 2144.05).

Referring to claim 38-39, Tomomura teaches the substrate surface has an off-angle of 5-15° from {100} plane to a {111}A plane, this reads on applicant's surface slanted from a (100) surface in a [011] direction or a crystal face which is equivalent.

Referring to claim 42, Tomomura teaches an evacuated chamber and a mean free path of a molecule of each source material is longer than a distance between the substrate and a source material ('822 col 2, ln 50-67).

Referring to claim 43, Tomomura teaches solid sources in Knudsen cells.

Referring to claim 44, Tomomura teaches a nitrogen compound decomposed at the growth surface ('822 col 3, ln 1-10)

Referring to claims 45-46, Jiang et al teaches a GaAs, Si or InP or the like substrate (col 3, ln 1-15).

Referring to claim 47-48, Jiang et al teaches a epitaxial deposition to produce a multitude of layers that comprise a complete vertical cavity surface emitting laser (VCSEL) (col 3, ln 1-25), this reads on applicant's semiconductor device.

Referring to claim 53-54, the combination of Jiang et al and Tomomura teachesusing in a single mode laser application, or as a random phase mask fro use in multi-mode laser application (Abstract), this reads on applicant's apparatus which uses the semiconductor device.

3. Claims 40-41 and 51-52 are rejected under 35 U.S.C. 103(a) as being unpatentable over Jiang et al (US 5,956,364) in view of Tomomura (WO 98/44539), where US 6,358,822 is used as an accurate translation, as applied to claims 29, 32-33, 38-39, 42-50 and 53-62 above, and further in view of Ito (Empirical interatomic potentials for nitride compounds semiconductors).

The combination of Jiang et al and Tomomura teaches all of the limitations of claim 40, as discussed previously, the semiconductor layer A including at least aluminum and nitrogen in it composition but not including indium in its composition and the semiconductor layer B including at least indium in its composition but not including nitrogen in its composition.

Ito teaches versatility of empirical potentials with AlN for various monolayer superlattices with InP or InAs (Abstract). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Jiang et al and Tomomura with Ito superlattice of AlN and InP or InAs monolayers because superlattices reduce lattice mismatch strain between layers.

Response to Arguments

4. Applicant's arguments with respect to claims 29, 32, 33 and 38-62 have been considered but are moot in view of the new ground(s) of rejection.

5. Applicant's arguments filed 11/7/2005 have been fully considered but they are not persuasive.

Applicant's argument that the prior art does not teach crystallizing nitrogen into a mixed crystal is noted but is not found persuasive. Tomomura teaches forming a mixed crystal layer of a III-V compound semiconductor which include nitrogen and at least one of the other Group V elements and at least one Group III element, such as Al (col 15, ln 1-35). Tomomura suggests

forming a mixed crystal which includes nitrogen and aluminum. Furthermore, Jiang et al teaches forming a InGaAsAlN epitaxial layer using MBE (col 3, ln 10-25).

Applicant's argument that the temperature range is noted but is not found persuasive. Tomomura teaches using a temperature range of 500-750°C (claim 4). Overlapping ranges are held to be obvious (MPEP 2144.05). Applicant's have not provided evidence of unexpected results in relation to the closest prior art for the claimed range. Also, applicant's argument that Tomomura does not teach supplying aluminum and nitrogen simultaneous is noted but is not found persuasive. Tomomura does not explicitly teach supplying aluminum and nitrogen simultaneously, however Tomomura does suggest supplying aluminum and nitrogen simultaneously, note column 15, lines 25-31. Also, Tomomura teaches the substrate temperature of 500-750°C when using NH_3, specially using a temperature of 580°C (col 7, ln 30-41). Furthermore, Tomomura teaches temperature is a result effective variable because decomposition efficiency and desportion are effected by the temperature of the substrate (col 7, ln 30-41); therefore optimization would have been obvious to a person of ordinary skill at the time of the invention.

Conclusion

6. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Hooper et al (EP 0864672 A2) teaches MBE of III-V nitride using ammonia and using aluminum (Abstract and col 7, ln 1-30).

Yang et al (High quality GaN and AlN grown by gas-source molecular beam epitaxy using ammonia gas as the nitrogen source) teaches employing ammonia in an MBE process as a nitrogen source because ammonia can easily dissociate due to a catalytic effect (pg 2354).

7. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J. Song whose telephone number is 571-272-1468. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Duane Smith can be reached on 571-272-1166. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Matthew J Song
Examiner
Art Unit 1722

MJS
January 15, 2006

ROBERT KUNEMUND
PRIMARY EXAMINER